vexed questions, relating to the actual condition of the Moon's surface, or its history in the past, can be regarded as approaching solution.

A FEW HINTS TO BEGINNERS IN SOLAR OBSERVATION.

By Miss E. Brown.*

In these days of widespread interest in astronomy there are, probably, many readers of popular essays, or of scientific magazines, who would gladly pass from the ranks of mere readers into those of actual workers, but who are deterred from making the first plunge by the impression that to the inexperienced beginner the accomplishment of any useful work is an almost hopeless aim; that to enroll themselves among real observers needs not only courage and confidence, but technical skill, or mathematical knowledge; and they probably feel that the mere play-work of an amateur, taken up and laid aside on the spur of the moment, and without definite object, will retain but a slender hold on their interest.

It is to such that I venture to offer a few words, based on personal experience, to show how a beginner *may*, from very small beginnings, if only he possess the two most necessary qualifications—accuracy and perseverance, attain to be ranked among those whose work will be welcomed and accepted by the greater scientific lights as a really useful contribution to astronomical knowledge.

When I first took up solar work, I possessed no observatory and no equatorially mounted telescope. I had only an old refractor, of 3-inch aperture, which had already seen a good deal of service, and which I used chiefly for a very elementary study of the Moon and planets, in accordance with the advice of the Rev. T. W. Webb, in his "*Celestial Objects for Common Telescopes*," to avoid looking at the sun "until hand and eye had acquired experience elsewhere."

It was a description given in "Proctor's Half Hours with the Telescope," of a method of observing sun-spots by projection, that induced me, a little later, to take up systematically that

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special line. For this a portable wooden frame was necessary, so constructed as to fit firmly into a small window. To the four sides of this frame were nailed triangular pieces of black calico of sufficient length to allow of the ends being wrapped round the tube of the telescope and fastened there by means of an elastic band, so as to exclude all light.

Dark glasses, which are risky things for the eyesight, were not necessary. A sheet of white cardboard placed on an easel at a suitable distance from the telescope—a yard is a good distance for a 3-inch telescope—formed the medium of projection, and, before darkening the room, the shadow of the telescope tube could, by a little shifting, be easily made to fall circularly upon it.

I shall not soon forget the delight with which, having completed this simple arrangement, I first saw, clear and sharp, the sun's image appear upon the cardboard screen, and noticed upon this image a few little dark spots, which I at once recognized as sun-spots, because, when the tube was shifted and the image of the sun moved, they also moved with it, which would not have been the case had they been merely specks of dust on the lens.

I may add that window curtains, if sufficiently dark and thick, will answer the purpose nearly as well as the above-mentioned apparatus. They must be pinned above and below the instrument, and a large square piece of cardboard, or of brown paper, must be slipped over the eye-piece by means of a small round hole, to shut out any interstices of light, but the necessity of darkening the room only applies to small telescopes. This, my first observation of sun-spots, took place when a minimum period of the sun-spot cycle was approaching, so that there were but few, often not any at all, to excite my interest, but, whether few or many, I at once began to sketch them in pencil whenever they appeared, preserving my sketches in a copy-book, and always marking the dates. One day I was showing these drawings to a friend, when it was suggested to me that I might send some of them to the Greenwich Observatory for inspection. This suggestion I ventured to carry out, and in a very kind letter received from Mr. W. H. M. CHRISTIE (now our Astronomer Royal), obtained the great encouragement of his friendly opinion that my drawings really would be useful for comparison with the photographs taken at Greenwich, and for a time I sent tracings of them to him regularly. Mr. CHRISTIE told me that the value of a series of drawing of sun-spots depended very much on the reg-

ularity with which they were made, and on the length of time over which they extended. He also laid special stress on the desirability of their position on the Sun's disc being correctly indicated, as, without this, in the frequent case of several groups being visible at the same time, their identification would be difficult.

Having at that time no equatorial, I was unable to carry out this injunction, although I did manage to show the relative positions of different groups in a rough way in my sketch-book. Moreover, when you have to be constantly shifting a telescope up or down, according to the sun's varying altitude, and moving it eastward on the screen to keep the image in the field—the difficulty of correct position-drawing is immensely increased. Even cross wires over the eye-piece will not help you much. It is true that if observations could invariably be made at noon, it would be comparatively easy, but this, in our changeful climate, is most uncertain. Thus, to continue the record of my early experiences, time went on, but the maximum period had well nigh passed before I attained to the second and better furnished stage of my astronomical life, which made me the happy possessor of not only an equatorial, but of a little BERTHEN Observatory wherein to house it; and with which possessions came the greatly needed means of correct measurements of sun-spots. A kind friend, Professor THOMSON, who had been my chief helper in the adjustments of my new telescope, began at this time to seriously consider the possibility of devising some simple and reliable plan for the purpose, and the result of this was his invention of the now widely used "THOMSON'S Cardboard Discs," which have Mr. E. W. MAUNDER'S authority for giving the heliographic latitude and longitude to within one degree. These discs are four in number, three of them being reversible, thus forming, in a small compass, the seven discs required to correspond with the seven different positions of the solar axis as seen from the earth at different times of the year, the few necessary calculations of position being obtainable from the Ephemeris for Physical Observations of the Sun in the "*Companion to the Observatory.*" * To use these discs the best plan is to have a light frame which can be attached, with rods, to the eye-end of the telescope, at such a distance as to make the sun's image coincide exactly with the circle of the disc. To compute the areas of sun-spots, which can be done

* The A. S. P. possesses a set of these discs.

with any telescope, paper ruled in squares with four divisions to the inch, is very useful and convenient, and by reducing the projected image of the sun to a circle eight inches in diameter (the size of the cardboard discs), the value of each of these small divisions will be nearly 61″ of arc, or 27.075 miles in length at the sun's mean diameter; or, what amounts to the same thing, the value of 2° of linear measurement on the equator, as shown on the discs, will be 15.115 miles.

And now, having, if with some unavoidable egotism, as briefly and simply as possible, explained *how* to look at the sun and how we may see whatever is to be seen at any time on his surface, I will, in conclusion, venture to impress one or two maxims on all beginners. In the first place, if you would work to any purpose, expect at the outset, beyond the pleasure of being at work, few definite results; look for no great or stirring discoveries; be prepared for long periods when there will be little or nothing to record; but persevere. Make solar work part of your daily work; draw constantly what you see—to do this alone requires a long-practised eye and hand—note accurately the times of observation; above all things, only draw *what* you see. Faithful drawings from different localities, correctly marked as to date, instrument and powers employed, will be a welcome contribution to the directors of all good observatories. Your own interest will increase year by year. The history of a single group of spots, or faculæ, will have its variations and excitements, and *may* have its distinct scientific value. But remember if "Art is long," Science is slow. It only desires the truth. It waits for it; it finds in patient watching the reward of that satisfaction which all methodical and no desultory work gives. It is worth the labor involved, and the laborer who once begins to cultivate his field will rarely, if ever, leave it in disappointment or disgust.

CIRENCESTER, ENGLAND, February 12, 1891.

THE SOLAR ECLIPSE OF JUNE 6, 1891.

BY ORRIN E. HARMON.

The writer has computed the phases of this eclipse for four different places in the State of Washington, as follows: Olympia, Blaine, Walla Walla and Spokane Falls.

These places are situated so that predictions for them will